

SURVEY PLAN

For

JORGENSEN FORGE EARLY ACTION AREA REMEDIATION PROJECT

CONTRACT NO. XXXXX

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Attachments

Attachment F-1 – eTrac Resumes and Dredge Equipment

Appendix F: Survey Plan

1.0 Introduction

Jorgensen Forge is an operating facility that manufactures precision machine forgings from material grades that include carbon, steel, aluminum, titanium, and nickel based alloys. The facility has been operated by the Jorgensen Forge Corporation (Jorgensen Forge) since 1992 and was previously managed by the Earl M. Jorgensen Corporation (EMJ) from 1965 to 1992. In 1992, the United States Environmental Protection Agency (USEPA) placed the Lower Duwamish Waterway on the National Priorities List (NPL) and the Jorgensen Forge shoreline was included. Sampling activities to determine the extents of impacted sediments began in 2003. The results of the investigations concluded shoreline and bank soil and sediment along the Jorgensen Forge property contained elevated concentrations of PCBs that present a risk to human health. A final Engineering Evaluation/Corrective Action was approved by the USEPA in 2011 leading to the preparation of a Basis of Design Report for the Jorgensen Forge Early Action Area in March 2013 by Anchor QEA, LLC. (Anchor) on behalf of EMJ and Jorgensen Forge. A Bid Specification package and Design Drawings for the Early Action Area Remedial Action were prepared by Anchor and Envirocon was solicited to provide a proposal for completing the removal action.

This Survey Plan has been prepared by Envirocon for the Jorgensen Forge Early Action Area Project and is included as Appendix B to the Project Work Plan (which will be attached to the RAWP). Envirocon has developed this Survey Plan in accordance with Specification Section 014000 *Remedial Action Work Plan* and Specification Section 017123 *Surveying*. This document establishes how Envirocon will perform surveying and positioning control during all phases of work. The Survey Plan includes information on the methods, equipment, personnel and subcontractors to be utilized during the execution of this project to ensure accurate and timely surveying.

2.0 Survey Plan Introduction

The project will be using a real time kinematic-global positioning system (RTK-GPS) outfitted on various equipment and portable survey devices for guidance and data collection. RTK methods utilize a reference or base station that provides a real time correction via radio to the projects various GPS devices. Equipment outfitted with GPS systems use digital terrain models (DTM) for real time guidance to final grades. A survey grade GPS rover will be used to survey excavation and final grades when practicable for quality control. RTK techniques provide centimeter levels of accuracy; proper procedure and survey techniques are followed to achieve the equipment's highest level of accuracy. Properly trained personnel are assigned to manage all GPS systems and perform CAD related tasks.

3.0 Mobilization and Setup

All GPS equipment arrives at the project during project mobilization. The base is installed and consists of a Trimble SPS852 radio, Zephyr Geodetic 2 GPS antenna and a radio antenna. While the GPS and radio antenna are mounted outside with a wide view of the sky, the radio itself is mounted indoors with a constant supply of electricity. The equipment is not wireless and is connected to a constant power supply.

The GPS antenna is mounted atop a large steel building assuring the most visibility to the sky and free from objects that may cause GPS signal disturbance. The post will be erected permanent in nature and will not allow any movement or vibration as movement can cause incorrect positions or low accuracy GPS results. After the mount is built and GPS antenna affixed, the radio is connected to the antennas and programmed.

The GPS horizontal and vertical antenna positions are established using static methodologies. The static position is established by collecting a minimum of 4 and up to 8 hours of data and sent to the online positioning user service (OPUS) <http://www.ngs.noaa.gov/OPUS/about.jsp>. This data is then used in conjunction with static data collected at control points either set or on record with WASHDOT, NGS, the City of Seattle or the City of Tukwila that encompass the project. The horizontal position of the base point is established on the Washington North zone, NAD83 State Plane Coordinate System, in U.S. survey feet. The vertical position is in reference to the Mean Lower Low Water (MLLW) tidal datum.

A third party surveyor performs a quality control check on the GPS system. For redundancy purposes, the GPS system shall be checked with a rover to a minimum of two control points. One control point is established by the project, the other by the third party surveyor. Documentation shall be provided by the third party surveyor acknowledging the GPS system is properly calibrated to the site coordinate system.

Once the base point is established and broadcasting a correction, the GPS machines shall be setup. Prior to mobilization the machines will be installed with Trimble grade control (GCS900) systems. Each GCS900 system is programmed and calibrated to the project coordinate system. The coordinates of each machine are verified using the onsite rover.

4.0 Quality Control

Benchmarks are established throughout the project by EI and the third party surveyor to maintain quality control. On a daily basis the position of the benchmark is measured, recorded, and time stamped. The delta coordinates are checked for accuracy. If the delta coordinates are within the project tolerance, the base and rover are ready for their daily survey procedures. If the delta coordinates are out of project tolerance, then qualified personnel may troubleshoot the problem.

Equipment controlled by GCS900 shall be checked on a daily interval. The GCS900 systems are checked to a known point or real time against the on-site rover. The known point can be set and measured with the rover, provided the rover coordinates have been previously verified to any known project benchmark. The GCS900

system is checked by setting the measuring point of the bucket of the excavator or blade of the dozer to the known point. The date, time and deltas between the known points or rover are recorded to daily field notes.

5.0 Site Preparation

A site topographic survey shall be performed by a third party surveyor for uplands work and eTrac for in-water work. The pre-construction survey includes all areas affected by construction. Topographic data includes all improved site features including, but not limited to buildings, utilities, parking lots, storm sewers, sidewalks, and vegetation. The topographic survey will contain enough data to accurately represent topography prior to construction. The survey points are sent to the third party surveyor licensed in the State of Washington, who performs quality control checks, builds the topographic model, and drafts records drawings. The topographic surveys are used for the purpose of documenting pre-construction topography as well as performing volumetric computations.

We will provide layout work for any areas related to site preparation according to record drawings. Layout items including, but not limited to new utility locations, excavation limits, fencing, offices, construction entrances, and storm sewers. We have the capabilities and the knowledge to layout any component of a project provided that the features are provided on a CAD drawing, or, at a minimum, a comma delimited northing, easting, elevation, and description format. The GPS equipped machinery will allow for a great deal of “stake free” work, as the operators receive real-time data on excavation and backfill exercises.

6.0 Excavation and Grading

Excavation and grading will be performed in the area identified as the Uplands and Shoreline. All excavations and grading activities are monitored by the GCS900 systems, rover, or a combination of both. All final excavated and graded surface points are measured on an interval close enough to provide verification that all depths and grades have been reached. All excavation and grading verifications are performed on a daily basis, prior to covering with subsequent earth work. Every grading layer that requires imported material will be measured on an interval close enough to provide verification that all depths and grades have been achieved. The survey points will be sent to the third party surveyor once the work is completed and comprehensive as-built models may be created. The third party surveyor licensed in the State of Washington, will perform quality control checks, build the topographic models, and draft record drawings. The topographic survey or verification data is used for the purpose of documenting excavated and graded topography as well as performing volumetric computations after the data is verified.

7.0 Additional Survey Points of Interest

Additional features such as abandoned utilities and removed pilings will be surveyed prior to excavation. At the end of the project all recorded points pertinent to the daily record, such as removed pilings and abandoned utilities shall be sent to the third party surveyor for quality control and possible incorporation to any as-built drawings.

8.0 Equipment

Land Based Survey Equipment

Field personnel performing land based surveying will be using Trimble GPS field equipment to include SPS880 receivers with TSC2 data collectors. Standard checks will be performed at the beginning and end of each shift by checking into known points.

The excavator on shore will utilize all Trimble GPS equipment; an AS400s will be located on the boom, stick and “dog bone” of the bucket. The body of the excavator will be equipped with two (2) MS990 receivers, an AS410 body sensor and a CB460 (with the GCS900 system) in the cab.

Water Based Survey Equipment

RTK-GPS System

eTrac Engineering, Inc. (eTrac) will employ an excavator positioning system for navigation and positioning. The excavator positioning system will include angle, rotation, and magnetic closure sensors on the clam shell bucket, and eTrac inclinometers on the boom and stick integrated with two (2) precision RTK-GPS unit and positioning software. All sensors will employ real-time data formats and be integrated into Hypack’s Dredgepack software to provide a graphical and numerical depiction of the survey and template information while displaying the precise location of the excavator bucket.

The position and heading of the excavator will be determined by Real-Time Kinematic (RTK) GPS/GNSS. A base station will be established at the project site to provide consistent corrections for the equipment and survey vessels on the project. The base station will consist of a receiver, 900 MHz radio, geodetic satellite antenna, a 900MHz antenna, and a power supply.

The excavator will be equipped with a receiver with an internal 900 MHz radio to receive RTK corrections and dual satellite antennas to compute heading. The positional accuracy of the system is $\pm 10\text{mm}$ horizontal and $\pm 20\text{mm}$ vertical. Heading is computed to within 0.09° . The two satellite antennas will be fix-mounted to the top of the excavator. The separation (ΔX , ΔY , ΔZ) between the primary GPS antenna and the center of the boom will be measured. The offsets will be entered into the Dredgepack software to provide a precise location and orientation for the excavator arm assembly.

Inclinometers

Angle sensors or inclinometers called the TiltTrac system, designed and provided by eTrack will be employed to track movement of the numerous components of the barge/dredge system.

The individual TiltTrac sensors will be assigned an address in the daisy-chain in software. Dredgepack allows them to be used in many configurations such as boom, arm, stick, bucket angle, gimbal angle(s) and pitch/roll of the entire platform.

Bucket Rotation

Bucket rotation is measured using an eTrac custom designed magnetic rotary sensing system. Hypack has successfully integrated this sensor for past excavator instrumentation integration projects.

Bucket Open-Close

Bucket Open/Close is measured using an eTrac custom designed magnetic linear sensing system.

Excavator Barge Instrumentation

RTK GPS/GNSS will be used for positioning and heading of the excavator barge. Information from the barge GPS will be sent to the excavator cab for use by the Dredgepack software to display barge position. To measure draft of the excavator barge a submersible level transducer will be used. It will be calibrated to one hundredth of a foot and interfaced with a custom eTrac circuit to provide the analog to digital conversion necessary for incorporation with the Dredgepack software. This circuit will wirelessly transmit this information to the excavator cab.

Electronic Tide Measurement

The *TideTrac* system will provide for real-time wireless electronic water level monitoring. The remote viewing unit with its integrated radio package will provide serial output directly into Dredgepack. The system will be checked against the NOAA tide gauge each day and adjusted to MLLW.

Computer Software and Interface

All sensor cable terminations and receiving radios will be housed in a weatherproof enclosure external to the excavator cab. Rugged marine-grade laptop computers, such as the Panasonic Toughbook, will be used. An additional LED monitor for the CQA staff next to the excavator operator will be provided. A docking station will provide extra inputs and allow the system to be removed and/or replaced quickly. Backups of data will be provided regularly using backup software and stored at an off-site server.

HYPACK Dredgepack software will be used for sensor integration, calibration, data output display, visualization of machinery operation, and displaying of bottom conditions updated both with Multibeam Survey data and during real time dredging/filling operations. Calibration of the system is performed in the HYPACK software with a proven method of measurement of pivot point distances and with a prescribed set of geometry setups that is easily repeatable by the dredge operator if the system is returned to a known point on the deck of the barge.

Secure access to the dredge's computer screen, keyboard, and trackpad will be enabled through a remote login service. Files can be transferred, survey matrices updated, and system health can be monitored without interrupting the dredging/ capping operation. Total positional accuracies of the system at the excavator-bucket lip, depending on boom, stick, bucket, and other baseline measurements is capable of being achieved to within approximately 3-6 centimeters.

Backup (To Prevent Down Time)

Backup sensors and cables will be on hand for a quick change out in the event of failure. Change out takes less than an hour.

Telemetry to Dredge Oversight Office

A Local Area Network (LAN) will be constructed on the project site to connect machinery equipped with electronics to the Dredge Oversight Office computers and other mobile platforms. The LAN will be tied to the internet via a firewall that will allow control over security and access. The WAN will allow secure access to off-site programmers, technicians, and project personnel for monitoring the status of the project as required in the specifications.

9.0 Hydrographic Survey Services

Surveying

eTrac will provide on-call, 24/7 full-service survey support for dredging and backfill operations in-water. eTrac operates 5 trailerable, aluminum geophysical survey vessels which are configurable for multibeam, singlebeam, side-scan, sub-bottom, and magnetometer surveys. eTrac's skilled surveyors will be overseen by Washington-licensed professionals. eTrac's team carries extensive experience specific to the dredging industry. The team is also cross-trained to cover dredge positioning, telemetry, and project coordination. Resumes of planned surveying personnel are included as Attachment F-1.

Survey operations will be accomplished under the direct supervision of an ACSM (CIH Certified Inshore Hydrographer) and/or PLS certified surveyor. Management and daily products will be provided either in the form of a processed and tide-corrected x, y, z dataset or, if required, as full-fledged AutoCAD plan and cross section hard and soft-copy plots complete with volume computations and daily report logs. eTrac will provide surveys to document site conditions at various stages of the Dredging Project including, but not limited to:

- Pre-Construction Baseline Survey
- Progress Surveys
- Post Dredge Acceptance Survey/Pre-Backfill Survey
- Final Sand Backfill Acceptance Survey
- Final Filter Materials Acceptance Survey
- Final Riprap Acceptance Survey
- Final Habitat Substrate Acceptance Survey
- Record Document Final As-Built Survey

In addition to surveying, eTrac will perform the following activities:

- Verification of existing control points
- Establishing supplemental benchmarks, control points, staff gauges, etc., as necessary
- Installing tide gauge

- Initial layout of work elements
- Daily calibration and verification of survey system accuracy
- As-built surveys and construction record drawings
- Calculation of construction quantities
- Maintenance of the project record drawings

Survey Vessel Equipment

- Survey Platform Hardware and Software
- R2Sonic 2024 Multibeam Echo Sounder
- Applanix POS MV 320 RTK-enabled Version 4 – Position and Orientation System
- Valeport Mini SVS Sound Velocity Sensor
- Odom Digibar Pro Sound Velocity Profiler
- Qinsy/Qcloud and/or HPACK/HYSWEEP Survey Acquisition and Processing Software
- AutoCAD Civil 3d 2011, TerraModel, HYPACK, Global Mapper, ESRI ARC, Fledermaus/Caris software, as required.
- Custom Rack-mounted Multibeam Acquisition and Processing Computer
- Pure Sine-wave Inverter/Charger with house bank batteries for quiet, reliable AC power

GPS / Radio Modem Hardware

- Base Station: Trimble SPS851 Modular GNSS GPS Receiver w/ Zephyr Geodetic Model 2 Antenna
- Trimble 35W High powered Base Radio Modem Data Link – Transmit
- Trimble 2 W PDL 450 MHz Radio Modem Data Link - Receive

Additional Hardware

- VHF Radios
- USCG and Project-required Safety Equipment
- LAN-based Project-wide Wireless Connectivity with Dredges and Office Computers
- WAN-based, Remote Secure Access to remote processing/CAD resources, if required.

10.0 Topographic Surveys

Surveying

For all non-payment topographic surveying support, Envirocon's skilled surveyor will be overseen by a third party Washington-licensed professional for daily progress surveys. A locally operating third party professionally licensed land surveyor or someone operating under their direct supervision yet to be determined will provide on-call, full-service survey support for excavation and backfill payment surveys for upland and banks/shoreline areas.

Survey operations will be accomplished under the direct supervision of a PLS certified surveyor. Management and daily products will be provided either in the form of a processed and tide-corrected x, y, z dataset or, if

required, as full-fledged AutoCAD plan and cross section hard and soft-copy plots complete with volume computations and daily report logs.

The third party surveyor will provide surveys to document site conditions at various stages of the Dredging Project including, but not limited to:

- Pre-Construction Baseline Survey
- Post Excavation Acceptance Survey/Pre-Backfill Survey
- Final Sand Backfill Acceptance Survey
- Final Filter Materials Acceptance Survey
- Final Riprap Acceptance Survey
- Final Habitat Substrate Acceptance Survey
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Envirocon will provide surveying support for the following activities:

- Progress Surveys
- Verification of existing control points
- Establishing supplemental benchmarks, control points, staff gauges, etc., as necessary
- Installing tide gauge
- Initial layout of work elements
- Daily calibration and verification of survey system accuracy
- Record Document Final As-Built Survey
- As-built construction record drawings
- Calculation of construction quantities
- Maintenance of the project record drawings

GPS / Radio Modem Hardware

- Base Station: Trimble SPS851 Modular GNSS GPS Receiver w/ Zephyr Geodetic Model 2 Antenna
- Trimble 35W High powered Base Radio Modem Data Link – Transmit
- Trimble 2 W PDL 450 MHz Radio Modem Data Link - Receive

Excavator-mounted Hardware

- Boom Mount: Trimble AS400 Angle Sensor and AS410 body sensor
- Operator Controls: Trimble CB460 Control Box with the GCS900 system

Additional Hardware

- AutoCAD Civil 3D 2013
- VHF Radios
- WAN-based, Remote Secure Access to remote processing/CAD resources, if required.

After completion of excavation and grading at the end of the project, a final topographic survey will be performed. The topographic survey shall include all areas that were disturbed in the course of work and any

newly constructed features. The final topographic survey points are sent to the third party surveyor licensed in the State of Washington, for quality control, modeling, and final record drafts.



Attachment
